Attachment D

AECOM Environment

Submitted to:
Schiff Hardin, LLP
Chicago, Illinois

Submitted by:
AECOM
Chelmsford, MA
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Characterization of 1-Hour SO_2 Concentrations in the Vicinity of the Labadie Energy Center

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1.0 Introduction

The United States Environmental Protection Agency (EPA) is implementing the 2010 1-hour SO_2 National Ambient Air Quality Standard (NAAQS)[1] in an approach that involves either a dispersion modeling or monitoring approach to characterize local SO_2 concentrations near isolated emission sources. On March 20, 2015, EPA informed affected states that certain emission sources within their states will be addressed in an expedited[2] round of designations under the 1-hour SO_2 NAAQS due to terms of the SO_2 Consent Decree negotiated between the Sierra Club and EPA. The EPA intends to designate the affected areas as either unclassifiable/attainment, nonattainment or unclassifiable by July 2, 2016 after a review of available modeling or monitoring data to support the SO_2 concentration characterizations. Before then, the states need to recommend designations by September 18, 2015 and the EPA will review these recommendations and issue their comments on these recommendations to the states by January 22, 2016. After a public comment period on the state recommendations and EPA comments ending March 4, 2016 and final input from the states by April 8, 2016, EPA will issue their final designation findings by July 2, 2016.

One of the affected sources is the Labadie Energy Center, located about 50 kilometers west of St. Louis, along the Missouri River (see Figure 1-1 for a map showing the source location and terrain in the vicinity). The purpose of this report is to provide information to the Missouri Department of Natural Resources (MDNR) regarding the results of a dispersion modeling characterization of SO_2 concentrations around Labadie. The plant's 700-ft (213-m) stacks are well above the surrounding terrain (less than 120 m of relief), so that any dispersion modeling application involves simple terrain. As this report describes, the dispersion modeling analysis was conducted using both the current regulatory defaults and using proposed EPA changes to the preferred modeling approaches.

1.1 Report Organization

Section 2 of this report describes the Labadie Energy Center and the other sources modeled. This section also describes the source of regional monitoring data that is used to represent distant source impacts. Section 3 describes the dispersion model approaches used in this study: the current default AERMOD modeling approach as well as the use of EPA-proposed low wind improvements to AERMOD. Justification for the use of the low wind improvements is provided in appendices to the report. Section 4 of the report describes the modeling results, and indicates that with modeling conducted in accordance with the Modeling Technical Assistance Document[3], the characterization of SO_2 concentrations results in a finding of NAAQS attainment. Appendices A, B, and C provide documentation for an interim use of the low wind options as a non-default model. Appendix D compares Jefferson City and Spirit of St. Louis airport data to historical tall-tower meteorological data taken near Labadie.

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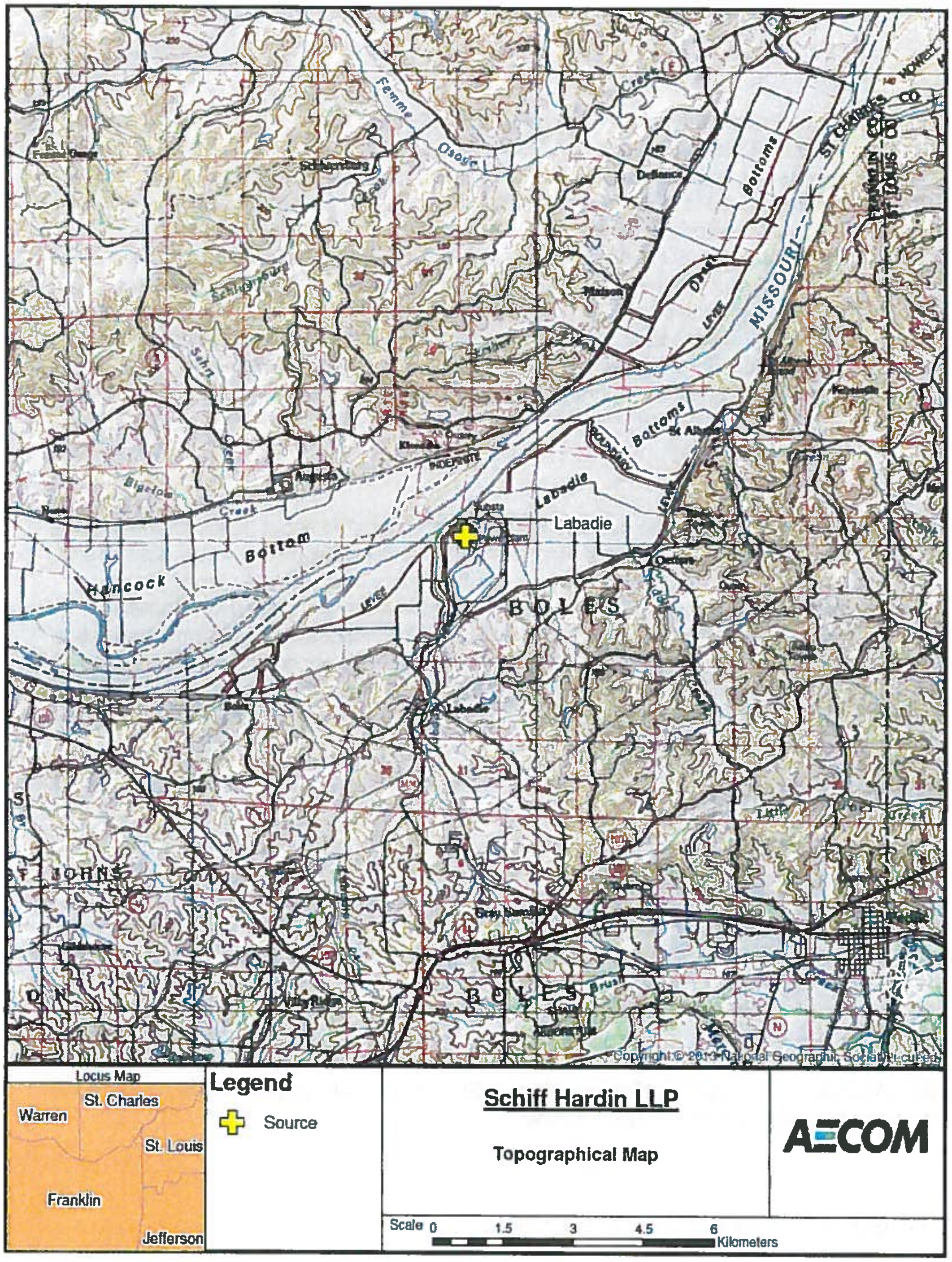
[1] 75 FR 35571 is the final rule for the 2010 SO_2 NAAQS.

[2] Information on the "SO_2 Consent Decree" is available at http://www.epa.gov/so2designations/data.html.

[3] http://www.epa.gov/airquality/sulfurdioxide/pdfs/SO2ModelingTAD.pdf.

Figure 1-1 Topographical Map Showing Labadie Site Location



2.0 Description of Modeled Emission Sources

2.1 Labadie Energy Center

Labadie Energy Center is a 2,407-megawatt coal-fired power plant located in Labadie, Missouri. The station operates four boilers exhausting through three 213-meter tall stacks (Units 3 and 4 emit from a dual-flue stack), as shown in Figure 2-1. The area surrounding Labadie is considered rural with mostly simple terrain out to approximately 50 km from the facility.

Figure 2-1: Labadie Energy Center Photograph

Credit: St. Louis Post-Dispatch; see http://www.stltoday.com/news/opinion/columns/the-platform/labadie-power-plant/image_740dccb2-a72b-11df-ac73-00127992bc8b.html.

2.2 Regional Background

According to the EPA March 1, 2011 Memorandum[4] and the analysis presented at the 2011 EPA modeling workshop[5], selection of regional background sources should be limited to 10 kilometers from the source location. Figure 2-2 shows the 10-km radius circle around Labadie Energy Center and two

[4] http://www.epa.gov/scram001/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

[5] Page 5 http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2011/Presentations/6-Thursday_AM/6-3_AB-3_Presentation_at_EPA_Modeling_Workshop.pdf

small SO_2 emission sources that emit less than 1 TPY that MDNR considered in this review. The nearest large SO_2 sources are more than 28 km away, which would place them at a distance for which a uniform background influence would be expected. Therefore, these more distant sources would not be expected to interact with Labadie to cause a significant concentration gradient near Labadie. The total concentration for 1-hour SO_2 NAAQS compliance was computed by adding the modeled concentration to the regional background concentrations from the Nilwood, Illinois monitor, shown in Figure 2-3.

The background concentration was calculated as a 3-year (2012-2014) average of the maximum concentration by season and hour-of-day and added internally in AERMOD to the AERMOD-predicted concentration for comparison with the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS) of 196.5 $\mu g/m^3$. The Nilwood seasonal SO_2 concentrations are displayed in Figure 2-4. Previous modeling by MDNR used a constant background value of 9 ppb derived from data collected at the East St. Louis, Illinois SO_2 monitor. MDNR excluded data from a large sector based on a wind trajectory analysis to avoid double counting of modeled sources. In this case, where Labadie is in a rural area with no other nearby sources, using background data from an urban monitor such as East St. Louis is conservative. The Nilwood monitor is located in a rural area of Illinois, similar to that of Labadie.

Figure 2-2: SO_2 Background Sources Included in Modeling

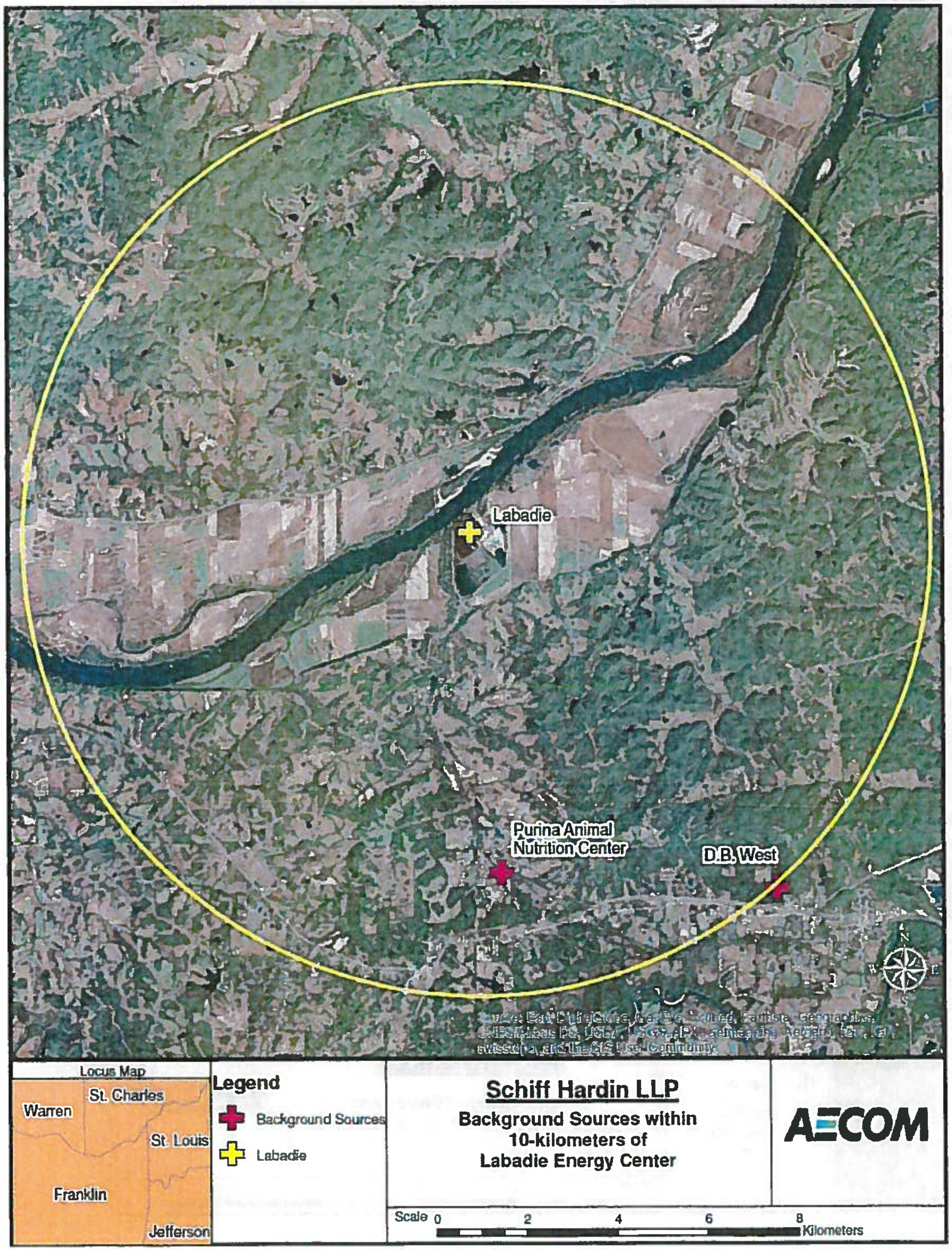


Figure 2-3 Nilwood Monitor Location with Respect to Labadie Energy Center

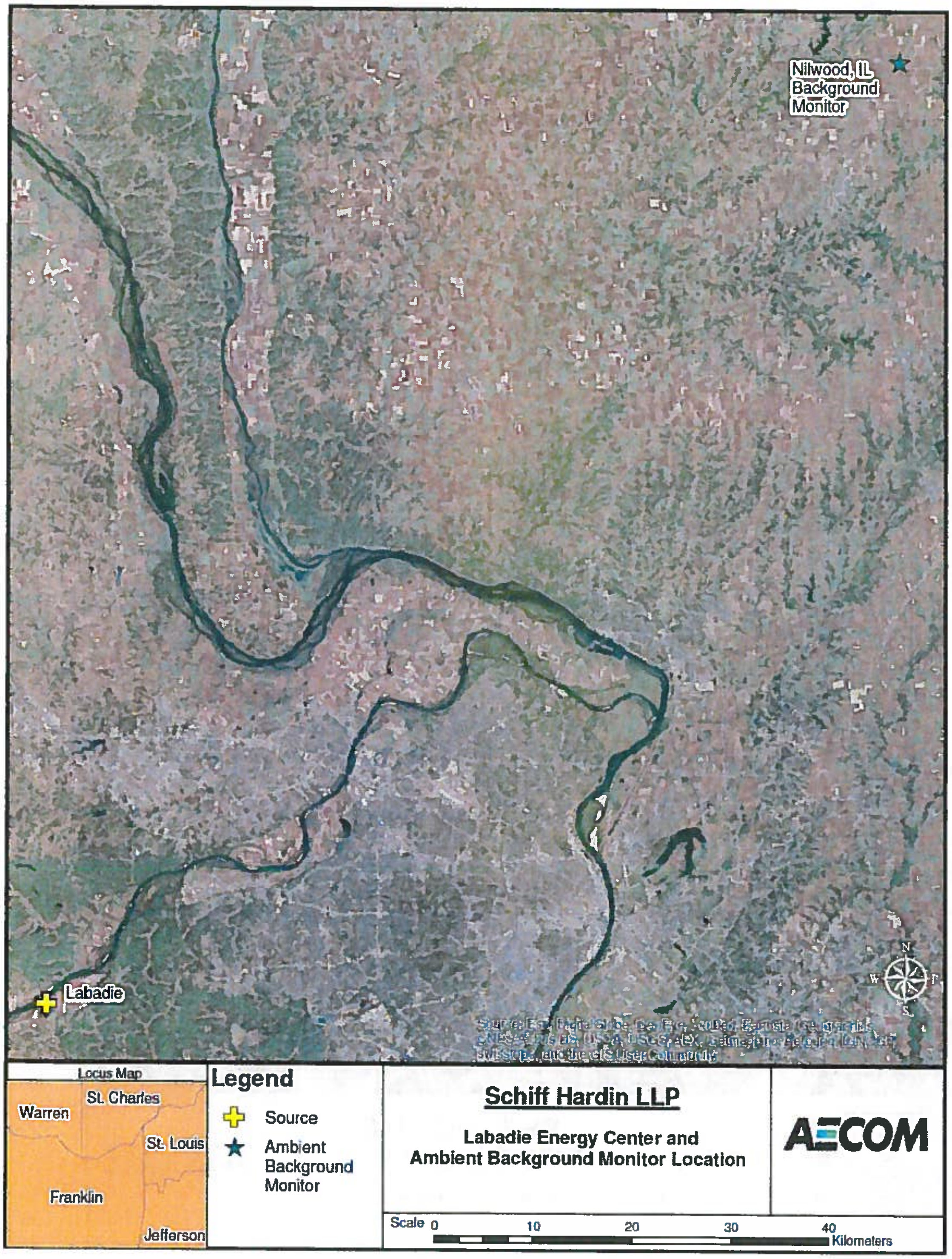
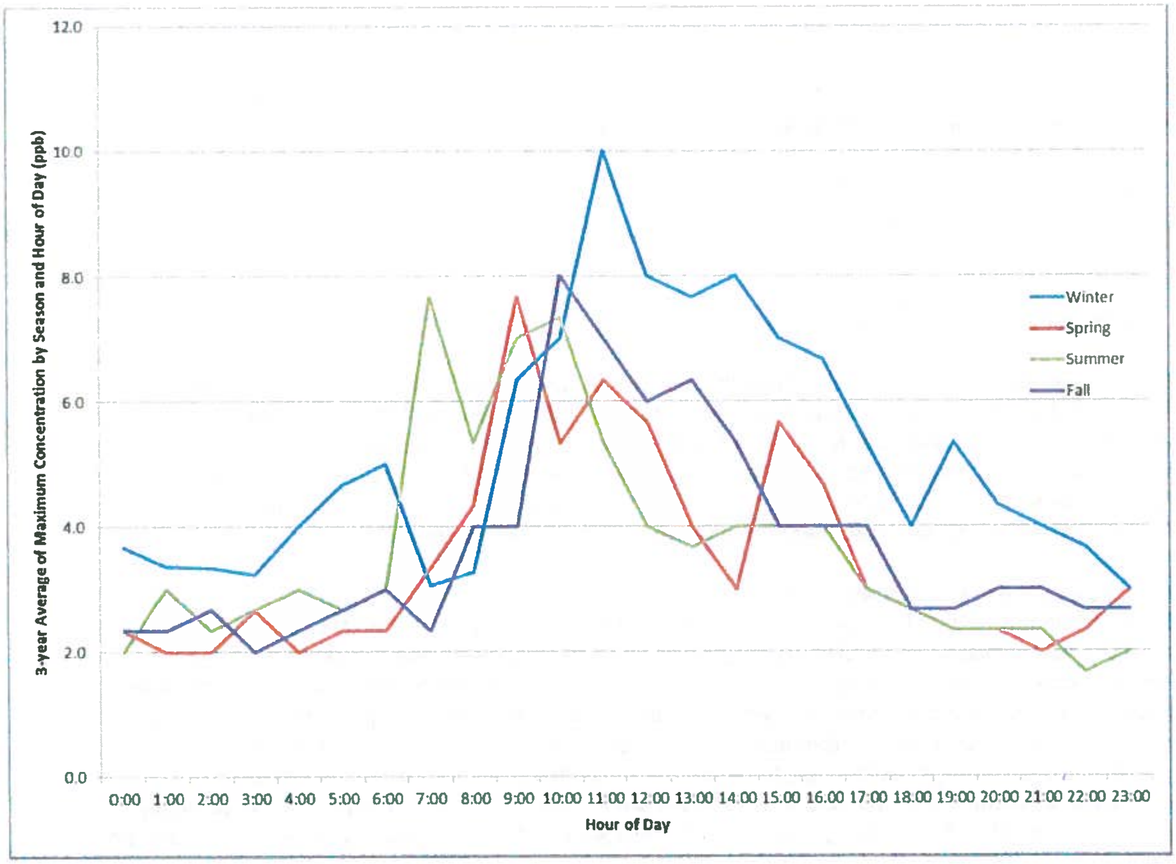


Figure 2-4: 2012-2014 3-year Average of Maximum Concentration by Season and Hour of Day at Nilwood SO_2 Monitor



3.0 Dispersion Modeling Approach

The suitability of an air quality dispersion model for a particular application is dependent upon several factors. The following selection criteria have been evaluated:

- stack height relative to nearby structures;
- dispersion environment;
- local terrain; and
- representative meteorological data.

The US EPA Guideline on Air Quality Models (Appendix W[6]) prescribes a set of approved models for regulatory applications for a wide range of source types and dispersion environments. Based on a review of the factors discussed below, the latest version of AERMOD (15181) was used to assess air quality impacts for the Labadie Energy Center. Previous modeling by MDNR used the previous version of AERMOD (version 14134). AERMOD version 15181 has "bug fixes" included that correct some errors in version 14134, so we have used the most recent version in this modeling.

In a proposed rulemaking published in the July 29, 2015 Federal Register (80 FR 45340), the United States Environmental Protection Agency (EPA) released a revised version of AERMOD (15181), which replaces the previous version of AERMOD dated 14134. EPA proposed refinements to its preferred short-range model, AERMOD, involving low wind conditions. These refinements involve an adjustment to the computation of the friction velocity ("ADJ_U*") in the AERMET meteorological pre-processor and a higher minimum lateral wind speed standard deviation, sigma-v (σ_v), as incorporated into the "LOWWIND3" option. The proposal indicates that "the LOWWIND3 BETA option increases the minimum value of sigma-v from 0.2 to 0.3 m/s, uses the FASTALL approach to replicate the centerline concentration accounting for horizontal meander, but utilizes an effective sigma-y and eliminates upwind dispersion".[7]

As this report describes, the dispersion modeling analysis was conducted using both the current regulatory defaults and using proposed EPA changes to the preferred modeling approaches with beta ADJ_U* and LOWWIND3 option. Documentation for an interim use of the low wind options as a non-default model are provided in Appendices A, B, and C. However, consistent with the EPA Appendix W, we anticipate that these proposed options will be promulgated as default options prior to the July 2, 2016 Consent Decree designation deadline, and therefore should be considered as more appropriate technical options to use at this time.

3.1 Good Engineering Practice Stack Height Analysis

Good engineering practice (GEP) stack height is defined as the stack height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant as a result of

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[6] http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf

[7] Addendum User's Guide for the AMS/EPA Regulatory Model – AERMOD
http://www.epa.gov/ttn/scram/models/aermod/aermod_userguide.zip

atmospheric downwash, wakes, or eddy effects created by the source, nearby structures, or terrain features. AECOM used the BPIP downwash parameters provided by MDNR in their modeling files.

3.2 Dispersion Environment

The application of AERMOD requires characterization of the local (within 3 kilometers) dispersion environment as either urban or rural, based on a US EPA-recommended procedure that characterizes an area by prevalent land use. This land use approach classifies an area according to 12 land use types. In this scheme, areas of industrial, commercial, and compact residential land use are designated urban. According to US EPA modeling guidelines, if more than 50% of an area within a 3-km radius of the facility is classified as rural, then rural dispersion coefficients are to be used in the dispersion modeling analysis. Conversely, if more than 50% of the area is urban, urban dispersion coefficients are used. As shown in Figure 1-1, the 3-km area surrounding Labadie Energy Center is rural. Therefore, rural dispersion was assumed.

3.3 Model Receptor Grid and Terrain

AECOM used the same receptor grid that MDNR used in their 1-hour SO_2 modeling. Figures 3-1 and 3-2 show the receptor network used in this analysis.

3.4 Meteorological Data Processing

MDNR conducted an analysis to determine the most appropriate meteorological station for use in the 1-hour SO_2 modeling. Another nearby station, the Spirit of St. Louis airport in Chesterfield, was considered. Although this station is closer to Labadie and in an area along the Missouri River with a similar orientation, MDNR chose the Jefferson City airport due to land use similarities. It is also evident from a comparison to historical tall-tower data taken near Labadie that the Jefferson City airport wind pattern is more representative Labadie stack-top winds than the Spirit of St. Louis wind pattern is (see Appendix D). For a sensitivity study, AECOM used the Jefferson City and the Spirit of St. Louis airports in this modeling analysis and found that the Jefferson City modeled results were slightly higher than the Spirit of St. Louis airport results. Therefore, we reported results for the Jefferson City data.

Figure 3-3 shows the locations of the meteorological stations mentioned above in relation to the Labadie Energy Center. Figures 3-4 and 3-5 show the 3-year wind rose for each station considered in the analysis.

3.5 Emissions and Stack Parameters

Schiff Hardin provided AECOM with the latest three years (2012-2014) of hourly SO_2 emissions and hourly stack exhaust parameters for Labadie Energy Center. AECOM reviewed the hourly emission data for this period. For modeling purposes, from the data provided, we created a 3-year (2012-2014) hourly emissions, exit velocity, and temperature file.

Table 3-1 Labadie Stack Locations and 100% Load Exhaust Parameters

Unit	X (UTM83)	Y (UTM83)	Stack Height (m)	Exit Velocity (m/s)	Temperature (K)	Diameter (m)
1	688352.17	4270445.59	213.36	34.72	443.06	6.25
2	688387.01	4270400.40	213.36	35.56	442.49	6.25
3 & 4	688435.47	4270332.33	213.36	34.95	441.71	8.84(1)
(1) Equivalent diameter for merged flues						

Figure 3-1: Labadie Modeling Receptor Grid – Far Field

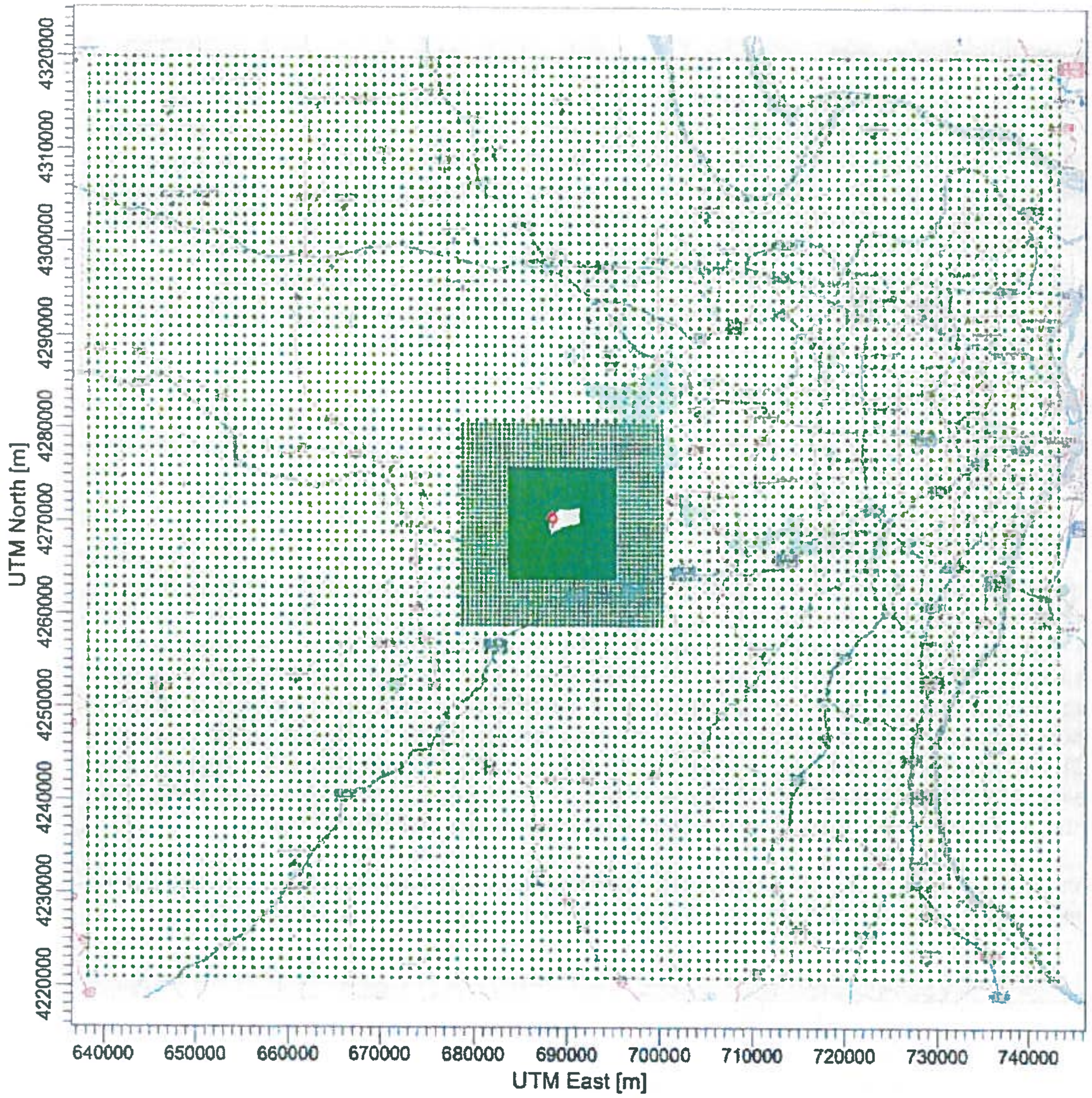


Figure 3-2: Labadie Modeling Receptor Grid – Near Field

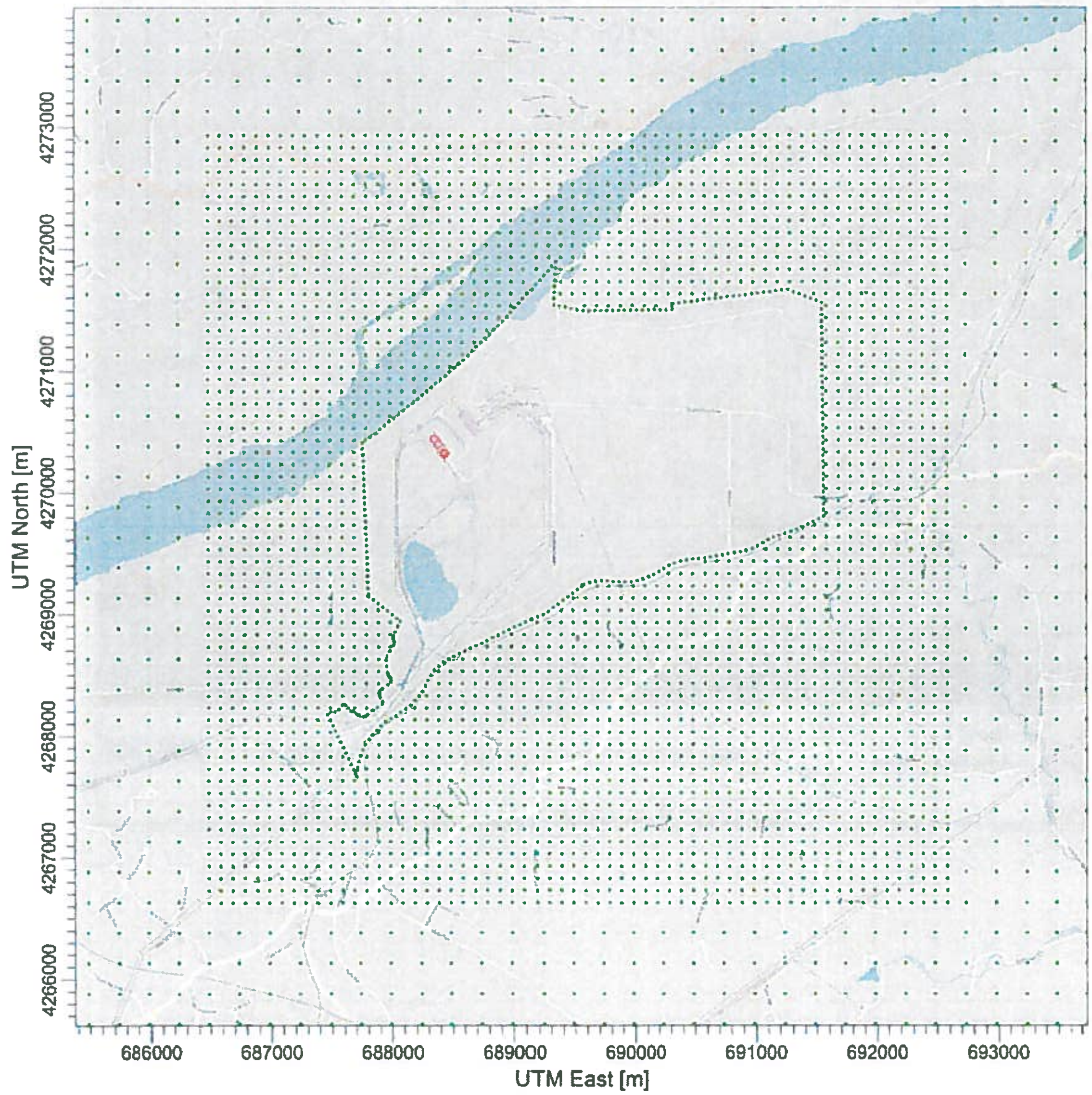


Figure 3-3: Location of Meteorological Stations Relative to Labadie Energy Center

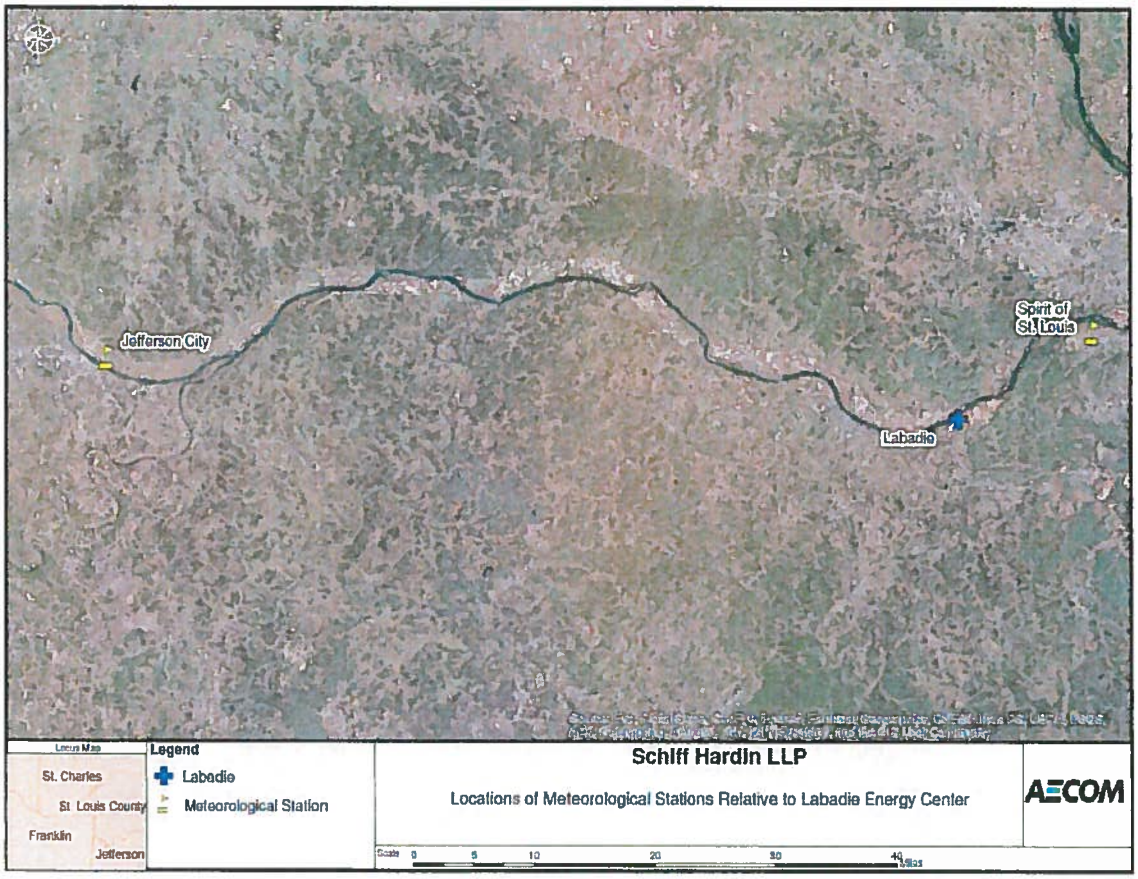


Figure 3-4: Jefferson City Wind Rose (2012-2014)

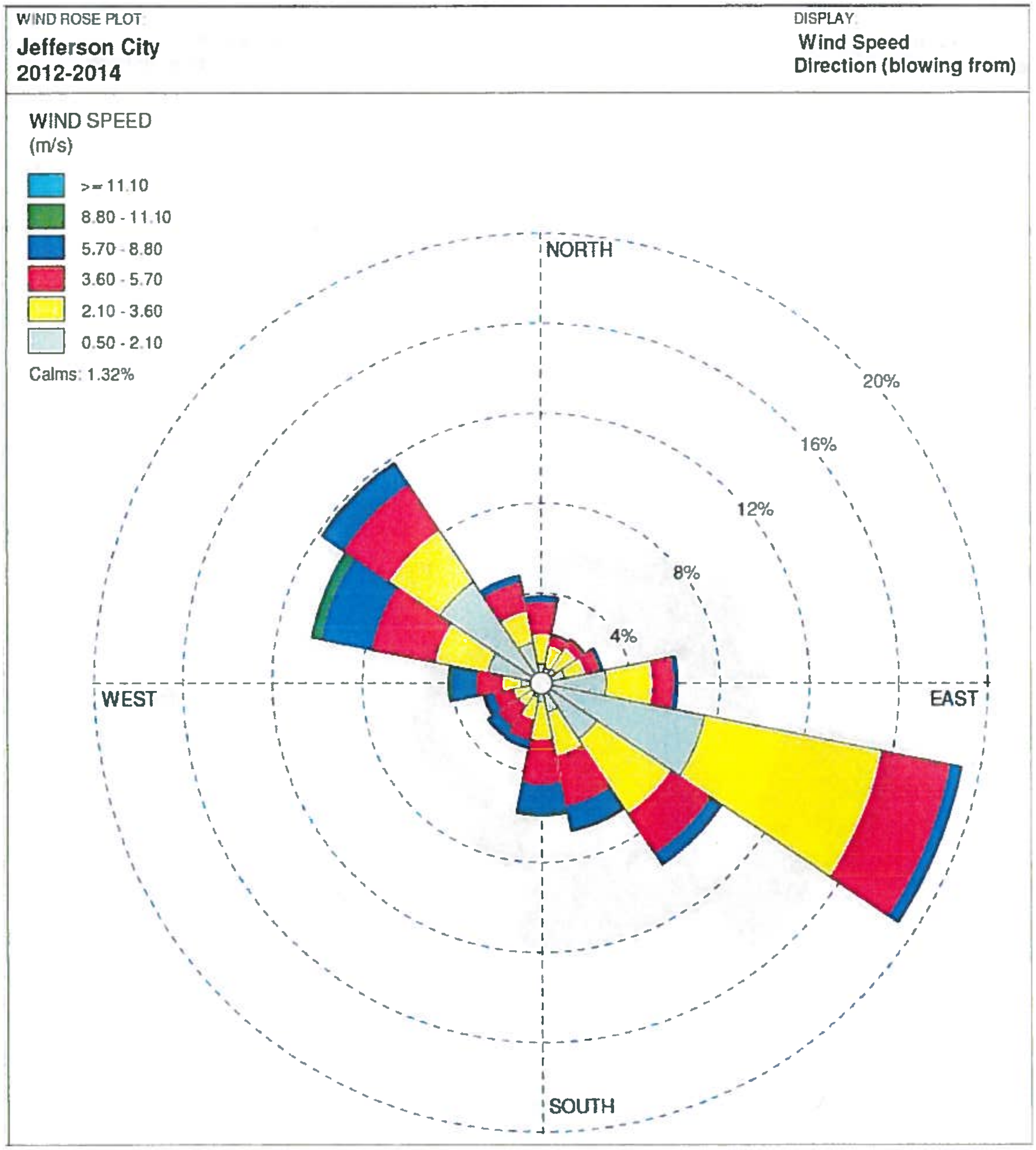
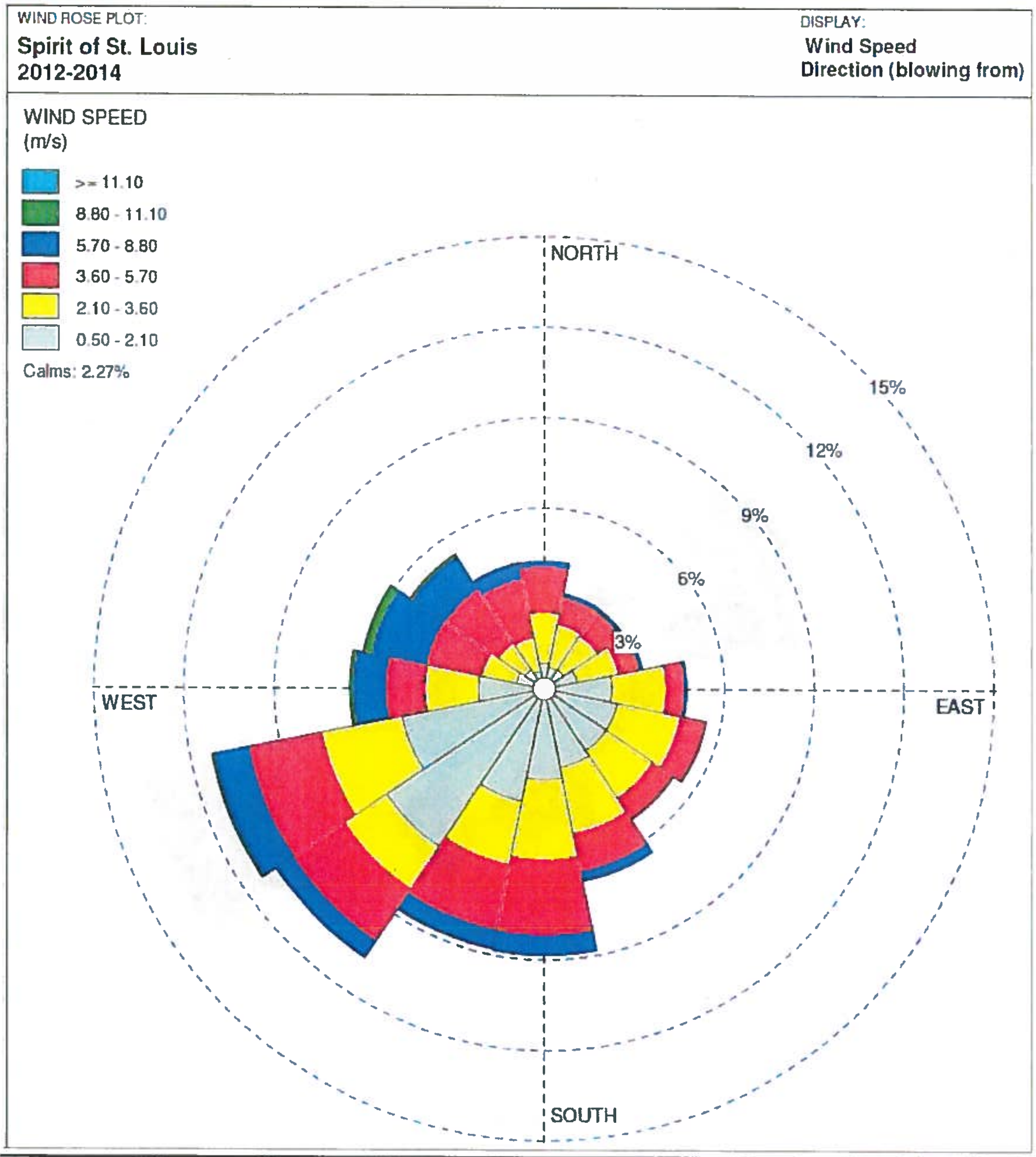


Figure 3-5: Spirit of St. Louis Wind Rose (2012-2014)



4.0 AERMOD Modeling Results

The modeling results of 99th percentile peak daily 1-hour maximum concentrations averaged over the 3 years modeled are presented in Table 4-1. The modeling was conducted with the EPA default option and beta ADJ_U* with LOWWIND3 options. The concentration isopleths for the ADJ_U* and LOWWIND3 options are plotted in Figure 4-1. Peak impacts from Labadie Energy Center occur in about 2 kilometers to the northwest, near the NW monitor installed in 2015.

An analysis of the AERMOD output in a debugging mode indicates that the meteorological and plume conditions associated with the controlling modeled impacts are due to a penetrated plume in convective conditions with a low mixing height. This feature and the tendency of AERMOD to over-predict in these cases are described in a presentation[8] delivered at EPA's 11th Modeling Conference. The presentation documents that the over-prediction tendency of AERMOD in these conditions can range up to 50%, which is generally consistent with the 10-40% uncertainty noted by Appendix W for modeling predictions in general. An over-prediction tendency of up to 50% applied to the results presented in Table 4-1 would show attainment of the NAAQS for both modeling approaches summarized in the table.

This modeling analysis, especially with the EPA-proposed improvements to AERMOD version 15181, supports the designation of the area in the vicinity of the Labadie Energy Center as being either attainment or unclassifiable for the 1-hour SO_2 NAAQS.

Table 4-1: AERMOD Modeled Design SO_2 Concentration Results

AERMOD Modeling Options	Labadie Concentration ($\mu g/m^3$)	Ambient Background Concentration from Nilwood ($\mu g/m^3$)	Modeled Design Concentration (2012-2014) with Seasonal Hourly Background from Nilwood ($\mu g/m^3$) (1)	NAAQS ($\mu g/m^3$)
Current Default (overall design conc.)	0.0	7.85	282.9(2)	196.5
Current Default (Labadie-caused design conc.)	212.30	20.64	232.9	196.5
ADJ_U* and LOWWIND3	172.36	20.64	193.0	196.5

(1) The "design concentration" is the 99th percentile peak daily 1-hour maximum concentration, averaged over the 3 years.
(2) This localized peak concentration near the D.B. West background source may be due to a conservative manner in which the stack source is characterized by MDNR.

[8] http://www.epa.gov/ttn/scram/11thmodconf/presentations/2-4_Penetrated_Plume_Issues.pdf.

Figure 4-1: 99[th] percentile 3-year average 1-hour SO_2 Concentration Isopleths with ADJ_U* and LOWWIND3 Options